Methods to Find the Cost-Effectiveness of Funding Air Quality Projects

A Comparison of the 1999 Edition to the
1998 CMAQ Emission Reduction Calculation Methodologies

The California Air Resources Board (ARB) and the California Department of Transportation (Caltrans) cooperatively provide methodologies to evaluate the cost-effectiveness of projects funded with federal Congestion Mitigation and Air Quality Improvement (CMAQ) Program funds or California Motor Vehicle Registration Fee (MV Fee) Program funds. The methodologies are updated annually. The 1999 Edition is a single document that contains methodologies to evaluate both CMAQ and MV Fee projects. This summary of changes compares the 1999 Edition to the 1998 CMAQ methodologies. First is a snapshot of changes followed by explanations.

New in the 1999 Edition!
On-road and off-road cleaner vehicle methods
Employer-based ridesharing methods
Emission factors for commuter express buses, on-road and off-road heavy-duty vehicles, and for light- and medium-duty cleaner vehicles

Revisions affecting all methodologies
Cost-effectiveness based on funding levels
Formulas for annual emission reductions, cost-effectiveness, and unit conversions
Carbon monoxide (CO) emission factors for limited use
Example calculations

Revisions in Individual Methods
<u>Operation of New Bus Service</u>
Buses must be cleaner vehicles
Deducts access auto trip emissions from benefits

<u>Replacing Old Buses with New Diesel Buses</u>
Old method is replaced with On-Road Cleaner Vehicle Purchases and Repowering

<u>Vanpools and Shuttles</u>
Van trip ends not needed due to new, per-mile medium-duty vehicle emission factors
Deducts access auto trip emissions from benefits

<u>Signal Coordination</u>
Uses Average Daily Traffic (ADT) during congested periods
Assumes benefits go from maximum to zero in 5 years
Percent improvement in speed ranges from 7.5% to 25%

<u>High Occupancy Vehicles (HOV) Facilities</u>
Old method is undergoing review and not included in the 1999 Edition. A revised methodology will be available as a supplement to the 1999 Edition in late 1999.

<u>Bicycle Facilities</u>
Determines expected increase in biking based on facility design, average commuter bike mode split, community population and type, traffic volumes, number of activity centers in corridor, and the length of the bicycle facility.

Telecommunications
Variations provided for home-based telecommuting, telecenters, and teleconferencing
Deducts access auto trip emissions from benefits

Ridesharing and Pedestrian
Offers three ways to estimate benefits from employer-based programs
Can be used to evaluate pedestrian facilities and Transportation Management Organizations (TMOs)

New in the 1999 Edition!
The following methodologies and emission factor tables were not previously available in the 1998 CMAQ methods: on-road and off-road cleaner vehicle methods; employer-based ridesharing; and emission factors for commuter express buses, on-road and off-road heavy-duty vehicles, and light- and medium-duty cleaner vehicles.

Revisions affecting all methodologies
Cost-effectiveness based on funding levels
The 1998 CMAQ Emission Reduction Calculation Methodologies recommend that emission reductions be used to prioritize projects in order to make sound funding decisions. The 1999 Edition continues to provide emission reduction formulas but also provides formulas to determine project cost-effectiveness as a means to better assess and prioritize the spending of clean air dollars.

Formulas for annual emission reductions, cost-effectiveness, and unit conversions
All methodologies in the 1999 Edition calculate annual emission reductions in pounds per year. Pounds per year is a common unit for reporting emission reductions from air quality projects for both the MV Fee Program and the Carl Moyer Program, a California program that funds heavy-duty, on- and off-road engine repowers and conversions.

Federal Highway Administration (FHWA) requests that emission reductions from CMAQ projects be reported in kilograms per day. Conversion formulas are provided to convert annual emission reductions to kilograms per day for this purpose.

Formulas are provided to determine cost-effectiveness as well. Cost-effectiveness is determined by dividing funding dollars by annual emission reductions. Funding is discounted using a capital recovery factor based on the project's useful life and a discount rate. The capital recovery factor calculated to two decimal places is the same for discount rates 4.75% and 5%. The method for determining cost-effectiveness is also consistent with the Carl Moyer Program.

Carbon monoxide (CO) emission factors
FHWA requests that CO emission reductions be reported for CMAQ projects. California's MV Fee Program does not request CO information. CO is a localized pollutant and not a regional pollution problem. Most projects using CMAQ and MV Fee dollars are funded primarily to reduce regional ozone and PM10 and have little impact on localized CO hot spots.

Signal coordination projects, however, may be targeted at specific CO hot spots in CO nonattainment areas. CO emission factors are included in the 1999 Edition in order to report to FHWA on these types of CMAQ projects. Reporting CO emission reductions should be limited to targeted projects located in CO nonattainment areas (Los Angeles and Imperial counties) or projects in CO maintenance areas.

In addition, CO emissions are several orders of magnitude larger than ozone precursors. CO overwhelms cost-effectiveness ratios unless CO emission reductions are scaled back significantly, typically by a factor of seven. This adjustment should be made when using cost-effectiveness ratios as a basis for funding decisions. Another option is to consider CO projects separately from ozone precursor projects.

Example calculations

Example calculations are provided for each methodology in the 1999 Edition to help the user better understand how to accurately use the formulas, interpret defaults, and determine appropriate emission factors.

Revisions in Individual Methods

Operation of new bus service

The 1999 Edition clarifies that new bus services funded with clean air dollars must be cleaner vehicles. In order to offset air pollution emissions from a new diesel transit bus, the bus service must operate at full capacity. Thus, in order to be a clean air project, the bus in service must be cleaner than the typical new bus. The methodology also reduces benefits to account for emissions from autos used to access the transit service.

Deletion: replacing old buses with new diesel buses

The 1999 Edition replaces this methodology with on-road cleaner vehicle purchases and repowering. Emission reductions are achieved already from normal fleet turnover as engines meet tighter emission standards; therefore, CMAQ and MV Fee dollars should be used for buses that are cleaner than existing standards. There can be short-term benefits if older diesel buses are replaced with new diesel buses significantly ahead of the normal replacement schedule; however, there is considerably more benefit from replacing diesel buses with cleaner, alternative fueled engines that have half the emissions of a diesel bus.

Vanpools and shuttles

This methodology has been simplified. Van trip ends are no longer an input to the formula. Emissions are calculated using per-mile medium-duty vehicle emission factors. The methodology also reduces benefits to account for emissions from autos used to access the van or shuttle service.

Signal coordination

Fuel Efficient Traffic Signal Management Program (FETSIM) evaluations indicate that maintaining the benefits of signal timing projects requires training and ongoing effort. Typically, traffic flow improvements that occur immediately after implementation of a project gradually decline to no improvement three to five years later. As a result, the methodology calculates average annual speed improvements as one-half of the first day, which represents maximum benefits and assigns projects a useful life of 5 years. Speed improvements range from 7.5% to 25% depending on project parameters. ADT used in the calculations is adjusted for congested periods of the day.

There is a perception that decreasing traffic accelerations will significantly reduce emissions. In fact, emissions from accelerations are most significant at high speeds rather than low speeds due to the volume of fuel through-put that occurs at high speeds. Signal timing typically reduces low-speed accelerations and results in limited, temporary benefits for air quality. In addition, speed improvements increase nitrogen oxides (NOx) emissions for average speeds above 30 mph.

There may be adverse indirect impacts resulting from signal timing that are not adequately addressed by the methodology. For example, traffic flow improvements favor auto travel over other non-polluting modes of travel like biking and walking. As a result, speed improvements may be counterproductive to meeting clean air goals pertaining to mode shifts.

HOV facilities
The old method is undergoing review and not included in the 1999 Edition. A revised methodology will be available as a supplement to the 1999 Edition in late 1999.

Bicycle facilities
The 1999 Edition corrects several deficiencies in the 1998 CMAQ method. The new methodology determines the expected increase in biking based on facility design, average commuter bike mode split, community population and type, traffic volumes, number of activity centers in corridor, and the length of the bicycle facility.

Telecommunications
This method has been fine-tuned to evaluate home-based telecommuting, telecenters, and teleconferencing. The method reduces benefits to reflect emissions from auto access trips.

Ridesharing and pedestrian
The 1999 Edition offers three ways to estimate benefits from employer-based programs. These methodologies may also be used to estimate benefits from pedestrian facilities and Transportation Management Organizations (TMOs).